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Theoretical Approach to Kinetic of Heat Transfer under Irradiation

Authors : Pavlo Selyshchev

Abstract : A theoretical approach to describe kinetic of heat transfer between an irradiated sample and environment is developed via formalism of the Complex systems and kinetic equations. The irradiated material is a metastable system with non-linear feedbacks, which can give rise to different regimes of buildup and annealing of radiation-induced defects, heating and heat transfer with environment. Irradiation with energetic particles heats the sample and produces defects of the crystal lattice of the sample. The crystal with defects accumulates extra (non-thermal) energy, which is transformed into heat during the defect annealing. Any increase of temperature leads to acceleration of defect annealing, to additional transformation of non-thermal energy into heat and to further growth of the temperature. Thus a non-linear feedback is formed. It is shown that at certain conditions of irradiation this non-linear feedback leads to self-oscillations of the defect density, the temperature of the irradiated sample and the heat transfer between the sample and environment. Simulation and analysis of these phenomena is performed. The frequency of the self-oscillations is obtained. It is determined that the period of the self-oscillations is varied from minutes to several hours depending on conditions of irradiation and properties of the sample. Obtaining results are compared with experimental ones.

Keywords : irradiation, heat transfer, non-linear feed-back, self-oscillations
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